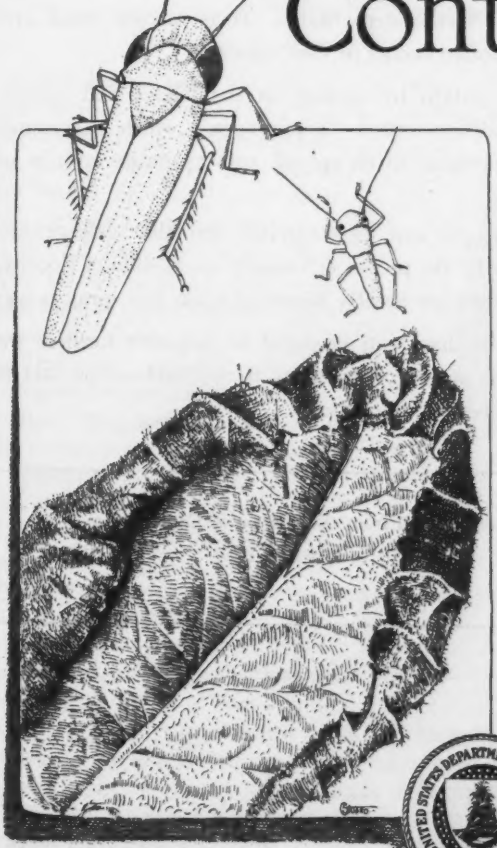
FARMERS' BULLETIN 1225
UNITED STATES DEPARTMENT OF AGRICULTURE

THE POTATO LEAFHOPPER *and its* Control



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THE POTATO LEAFHOPPER is a serious and costly enemy of potato, bean, sugar beet, and other crops in the North-Central and Northeastern States. It is a very small green insect which often occurs in vast numbers.

It injures potato by feeding on the foliage and causes a diseased condition called "hopperburn" which may, under conditions favorable to its spread, ruin an entire crop in one or two weeks.

This leafhopper can be controlled and the "hopperburn" held in check by the proper and timely application of Bordeaux mixture. Yields are greatly increased when this spray is used.

This bulletin has been prepared to acquaint farmers with the insect, the nature of its injury to vegetable crops, and the proper measures for its control.

Contribution from the Bureau of Entomology

L. O. HOWARD, Chief

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THE POTATO LEAFHOPPER AND ITS CONTROL.

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The potato leafhopper [1] is one of the most important insect enemies of potato in the United States. Serious outbreaks have occurred periodically in certain sections since the early eighties, and about 1896 this insect became known as a dangerous menace to the potato crop in the Middle and Eastern States. This leafhopper attacks a large number of plants and may at times become injurious on several of them.

The feeding injury, although severe, is not nearly as serious as the diseased condition called "hopperburn" which it transmits to the plants on which it feeds.

It is necessary to recognize and to fight this leafhopper to prevent the loss of large acreages of potatoes from "hopperburn."

FIG. 1.—Adult potato leafhopper. Greatly enlarged.

DESCRIPTION.

The adult or full-grown leafhopper (fig. 1 and fig. 2, G) is a very small, pale green insect, about one-eighth of an inch long, with large, white eyes and a more or less distinct H on its body between the head and base of the wings. There are six roundish, white spots above this H and three white, wedge-shaped spots below it. Adults fly and hop readily when disturbed.

[1] *Empoasca mali* LeB., order Hemiptera, family Cicadellidae.

The eggs (fig. 2, A) are tiny and transparent and are laid in the tissue of the potato leaf. The eggs can not be seen from the outside, but after they hatch the leaf tissue dies and forms small, sunken pits marking the previous location of the eggs.

The nymphs (fig. 2, B–F), or young leafhoppers, pass through several stages of growth and shed their skins several times, developing wings in the adult stage. When newly hatched, the nymphs are very small and nearly white, but slowly turn green as they grow. When the insect is nearly mature, the partially developed wings may be seen on each side of the body, and the "hopper" at this stage is quite active, being able to hop from leaf to leaf.

DISTRIBUTION.

The potato leafhopper occurs in practically every State of the Union and in parts of Canada and Mexico. Its greatest damage to potatoes has occurred in the Northern and Central States, roughly from Montana to New York and south to Ohio, Illinois, and Kansas.

ECONOMIC IMPORTANCE.

The economic loss to the potato grower caused by the attack of the potato leafhopper and the accompanying "hopperburn" is said to be second only to that caused by the Colorado potato beetle. In years when the leafhopper and "hopperburn" are abundant the combined loss may take first place in some regions among all potato insects and diseases. It is, therefore, essential that the grower become familiar with the insect, with the nature of its injury, and with measures for its control when a serious outbreak occurs.

SEASONAL HISTORY.

The potato leafhopper lives over winter in the adult stage, hidden away in brush heaps, matted weeds, and other protected places. Some time during May the leafhoppers emerge from their winter quarters, feed for a week or so on various trees and shrubs, then suddenly migrate to potatoes and beans where mating and egg laying begin. There are two generations of the insect in the Northern States with three, four, or perhaps five generations in the Central and Southern States.

Under Wisconsin conditions the adults which have lived over winter die off during July and their young mature about the last of July, forming the first generation. Thus it takes approximately one month from the time the eggs are laid until the adult leafhoppers appear. A second generation is now produced, although in a slightly shorter time, and the new adults begin to appear about the first of September. These adults live over winter and do not lay eggs until the next spring.

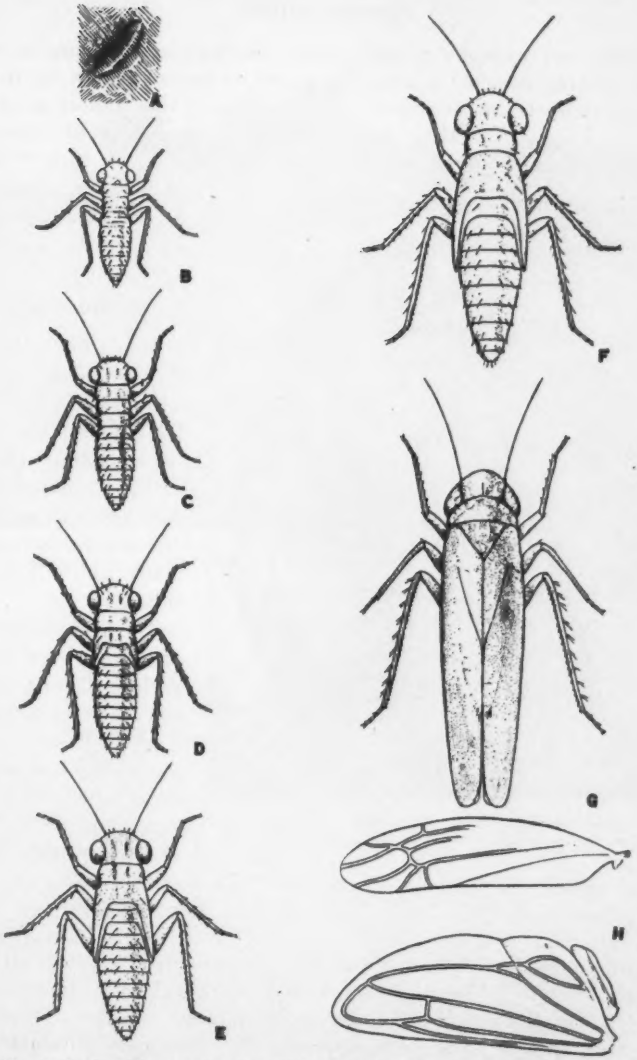

FIG. 2.—Stages in the growth of the potato leafhopper: *A*, Egg in tissue of leaf; *B-F*, stages of young leafhopper or nymph; *G*, adult leafhopper; *H*, fore and hind wings of adult leafhopper.

INJURY CAUSED BY THE POTATO LEAFHOPPER.

FEEDING INJURY.

Adults and nymphs of the potato leafhopper, in common with other sucking insects, extract the juices or sap of plants by means of their delicate beaks which they insert into the epidermis of the leaves. The injury thus caused through loss of plant juices is considerable and alone would cause the leaves to turn yellow. When a large number of leafhoppers are present the plant will sometimes wilt.

FIG. 3.—Potato leaf affected with "hopperburn." Upper surface of leaf showing typical upcurled brown tip and margin.

"HOPPERBURN."

In addition to the injury caused by loss of plant juices this leafhopper is the cause of a distinct injury called "hopperburn" which follows its feeding on potato and many other plants (fig. 3).

The first symptoms of "hopperburn" are a slight yellowing, usually of the tip of a leaf. As the disease progresses the leaf slowly turns brown, curls upward, and dies. The disease spreads from the tip or margin toward the midrib of the leaf, but spreads more slowly toward the base, and the basal area may remain green until the whole plant is nearly dead.

During periods of hot, dry weather "hopperburn" spreads rapidly and whole fields of early potatoes may be killed in a week's time (fig. 4). On the other hand, during cool, moist weather, or where protective sprays have been applied, the disease is checked and throughout the summer may progress no farther than the primary symptoms (fig. 5).

It has been found that even one or two leafhoppers placed on a healthy potato plant covered with a cage were able to cause sufficient "hopperburn" to kill the entire plant, while other caged plants kept free of leafhoppers remained healthy.

FIG. 4.—Early Ohio potatoes killed by "hopperburn." Great abundance of leafhoppers and a period of hot, dry, July weather caused these potatoes to succumb to "hopperburn" in a short time.

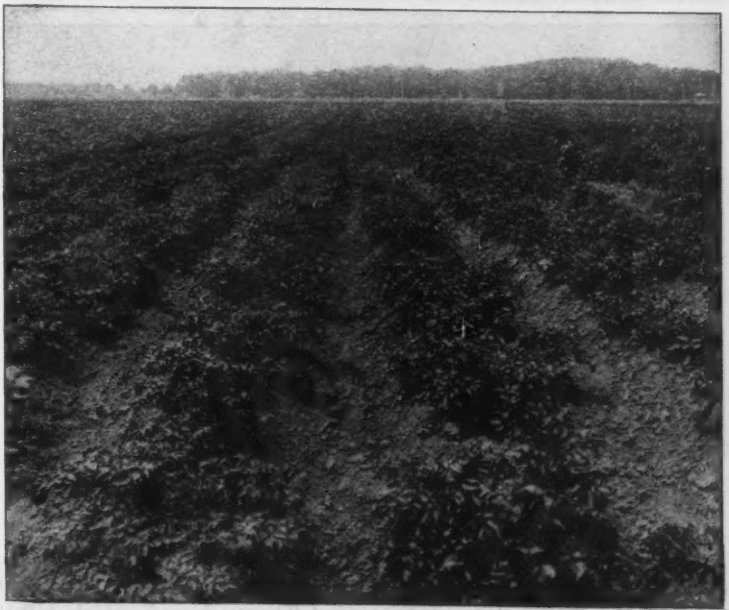

FIG. 5.—Main-crop potatoes protected from "hopperburn" by Bordeaux mixture. Two sprayings with Bordeaux mixture kept this field fairly free from "hopperburn."

Observations made in Wisconsin have shown that whenever leafhoppers were present in potato fields "hopperburn" could be found, and when no leafhoppers were present no "hopperburn" could be found.

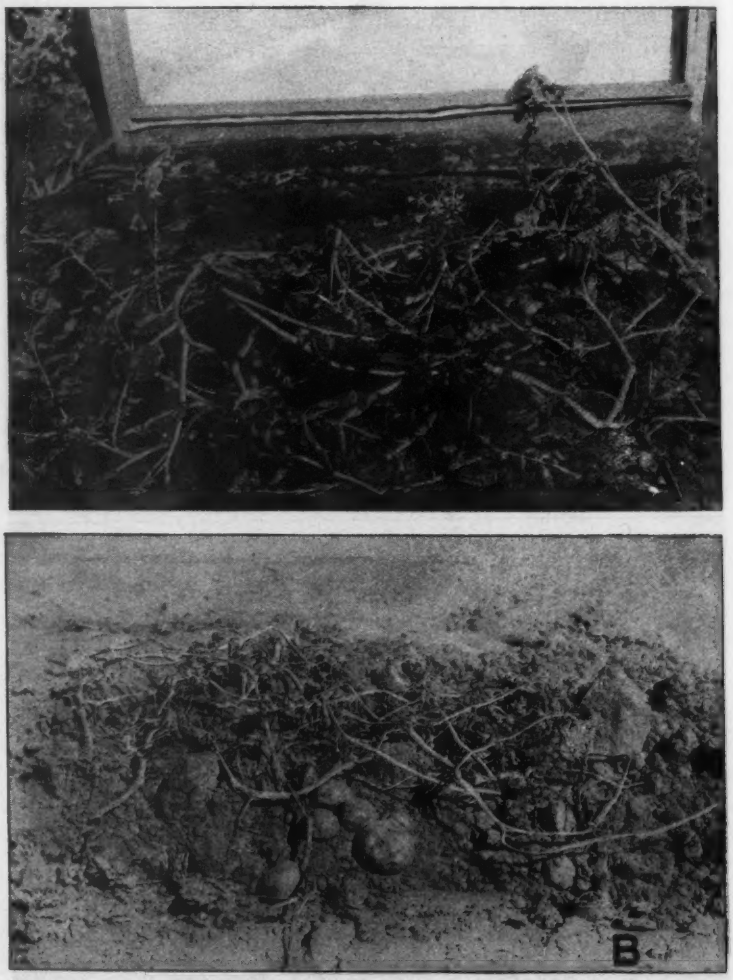

FIG. 6.—Presence of many "hoppers" means "hopperburn." Triumph potatoes growing in field, covered with large cage containing leafhoppers for entire season. *A*, Condition of plants on August 14; *B*, condition of same plants when dug on September 2. Compare with figure 7.

HOW "HOPPERBURN" AFFECTS DIFFERENT VARIETIES.

Leafhoppers placed on Early Triumph plants growing in a field and covered with a large cage caused "hopperburn" which killed the plants in 23 days (fig. 6, A and B). "Hoppers" placed on

Early Ohio vines under the same conditions caused "hopperburn" which killed the plants in about 40 days. Similarly "hopperburn" killed Irish Cobbler plants in about 55 days and Rural New Yorker

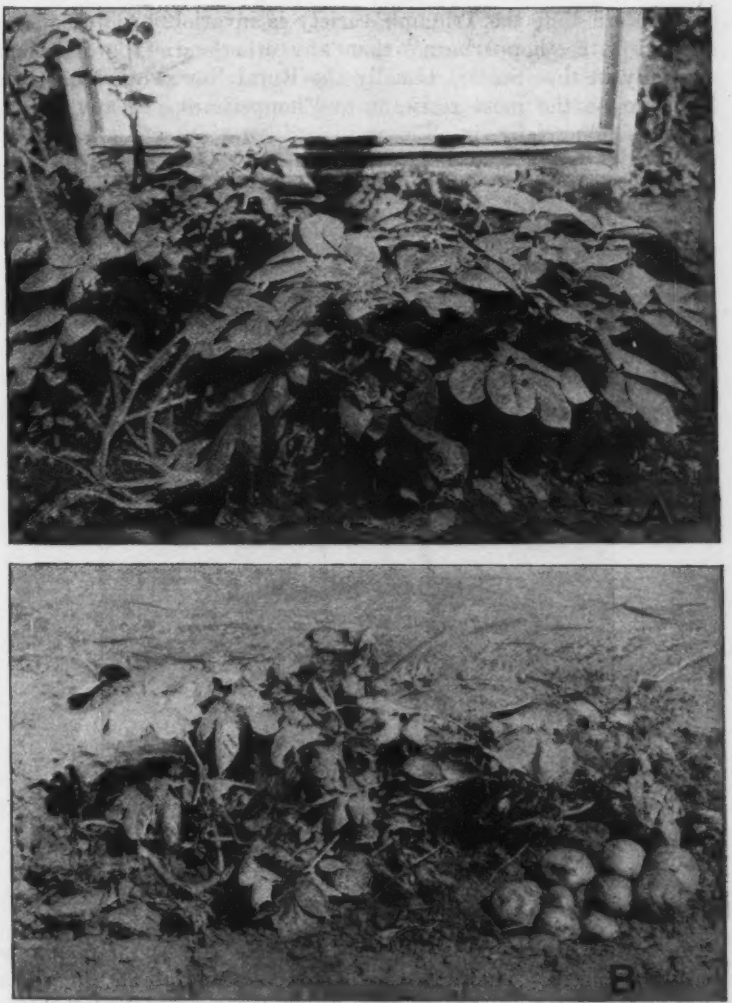

FIG. 7.—Absence of numbers of leafhoppers means no "hopperburn." Triumph potatoes growing in field, covered with large cage for entire season and kept free of leafhoppers. *A*, Condition of plants on August 14; *B*, condition of same plants when dug on September 2. Compare with figure 6.

plants in about 50 days. Green Mountain plants under like conditions became badly diseased, but were still alive two months after the leafhoppers were placed on them.

Plants of all the foregoing varieties which were caged and kept free of leafhoppers showed no symptoms of "hopperburn" during a period of two months (fig. 7, A and B).

Observations made in several potato-growing sections of Wisconsin have shown that the Triumph variety is invariably more severely affected with "hopperburn" than any other variety grown commercially in that State. Usually the Rural New Yorker has been found to be the most resistant to "hopperburn" of any variety grown commercially in Wisconsin.

FIG. 8.—"Hopperburn" accompanies leafhopper feeding. Apple seedling at left, covered with cage containing leafhoppers, developed "hopperburn" in a few days. Seedling at right, covered with cage free of leafhoppers, remained healthy.

FOOD PLANTS.

The potato leafhopper visits a considerable number of plants for feeding purposes. The more important economic plants on which reproduction takes place and "hopperburn" occurs are the following: Potato, beans (practically all varieties), sugar beet, hemp, apple, and raspberry. It also attacks several ornamental trees and shrubs. Reproduction appears to take place most readily on potato, with beans as a second choice. Hemp, sugar beets, and apple nursery stock are more liable to severe injury when growing near potato or bean fields.

It has been found that two leafhoppers placed on an apple seedling covered by a cage caused "hopperburn" which killed the seedling in a short time (fig. 8). The same is true of bean plants.

String, pole, and navy beans have been severely injured by "hopperburn," and if the plants were not killed the yields were greatly reduced. Lima and soy beans are not so heavily attacked nor is "hopperburn" ever severe on them, in Wisconsin at least.

Sugar beets are liable to attack when grown adjacent to potatoes, especially after the potatoes are nearly dead from "hopperburn," at which time there is a great migration of "hoppers" from potato to beets. So far, however, "hopperburn" has not become nearly as serious on sugar beets as on potatoes (fig. 9).

FIG. 9.—Sugar beets develop "hopperburn" when attacked by leafhoppers. Dead potato plants in adjacent row deserted by the leafhoppers.

NATURAL ENEMIES.

Although there are three natural enemies of the potato leafhopper, none has become important as a control. One, a tiny insect parasite,[2] breeds in the leafhopper eggs, but does not occur in sufficient numbers to reduce noticeably the number of "hoppers."

[2] Probably a dryinid.

A fungus [3] disease attacks both adults and nymphs. Leafhoppers affected with this fungus soon die and turn from green to yellowish in color. In a short time a heavy fungous growth, iridescent in appearance, i. e., having colors of the rainbow, appears on the insect's body (fig. 10). Warm, moist weather is necessary for the growth and spread of this fungus. In 1919 it was common all over Wisconsin and in certain localities practically "wiped out" the leafhoppers. In 1920, however, not a single specimen of the fungus was found.

Spiders often prey on both adults and nymphs.

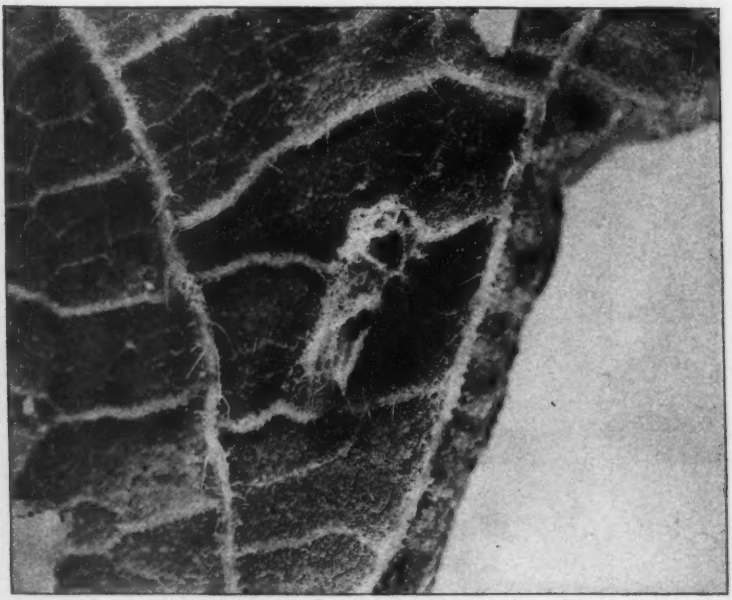

FIG. 10.—Fungous disease to check leafhoppers. The fungus has a rainbow-like appearance after covering body of the insect.

SELECTION FROM RESISTANT VINES.

Not only are certain varieties of potatoes less severely affected with "hopperburn" than are others, but some vines of any one variety are found to be more resistant to "hopperburn" than are other vines of the same variety.

Selections made at digging time of tubers from healthy and badly diseased vines when planted the following year gave interesting results. Of five varieties used—Early Ohio, Irish Cobbler, Green Mountain, Rural New Yorker, and Late Puritan—"hopperburn"

[3] *Entomophthora sphaerosperma.*

in every case was worse on plants which had come from tubers of diseased vines of the year before than on plants coming from tubers of healthy vines of the year before.

It is hoped that it may be possible in time to develop a strain of some varieties resistant to "hopperburn."

CONTROL OF THE LEAFHOPPER AND PREVENTION OF "HOPPERBURN."

USE OF BORDEAUX MIXTURE.

Results of two years' work have shown that Bordeaux mixture will repel the leafhopper, control "hopperburn," and is the best

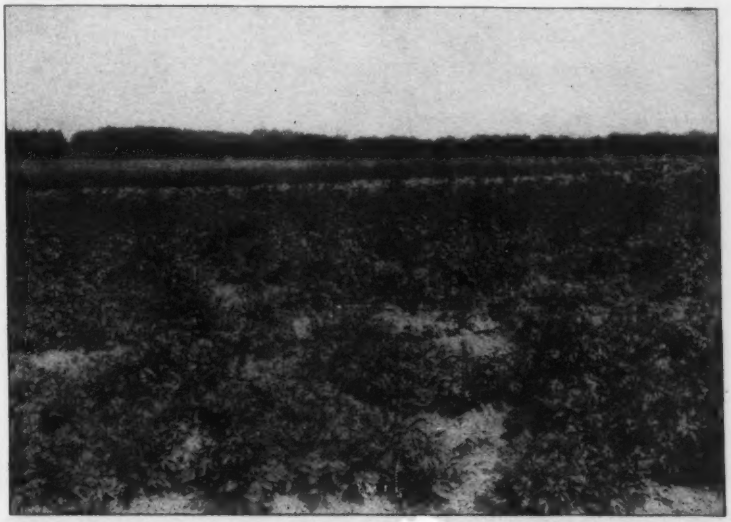

FIG. 11.—Potatoes protected from "hopperburn" by Bordeaux mixture: yield high. Five varieties shown here were given four sprayings with Bordeaux. Very little "hopperburn" present on August 23. Compare with figure 12.

remedy. Bordeaux mixture made according to the 4–4–50 formula, containing 4 pounds copper sulphate and 4 pounds unslaked lime to 50 gallons of water, was used.

Bordeaux combined with nicotine sulphate acts a little more quickly in ridding vines of leafhoppers than does Bordeaux alone, but the results obtained do not appear to justify the added time and expense of using the nicotine.

Nicotine sulphate and soap combined were found very effective in killing nymphs and a few adults present when the spray was applied. There was no lasting effect, however, because leafhoppers reappeared in a few days. "Hopperburn" was not controlled.

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Kerosene emulsion acted in the same way as nicotine and soap, killing the leafhoppers it hit, but having no lasting effect. Moreover, "hopperburn" appeared to be worse on these plants than on plants sprayed with any other material.

WHAT BORDEAUX WILL DO.

Bordeaux mixture properly applied to plants will drive away leafhoppers and keep the plants quite free of them as long as a good coating of spray is kept on the foliage.

Bordeaux will also very largely prevent the symptoms of "hopperburn" from developing and will check the spread of what has already

FIG. 12.—Potatoes not protected from "hopperburn" give poor yields. Five varieties shown here were never sprayed. "Hopperburn" killed all but late varieties, and even they were badly affected with "hopperburn" on August 23. Compare with figure 11.

appeared. (Fig. 11.) Unsprayed plants growing next to properly sprayed plants or even among them will be heavily attacked by "hoppers" and become badly affected with "hopperburn." (Fig. 12.)

The effect of Bordeaux on "hopperburn" varies with different varieties. Rural New Yorker plants well sprayed have remained almost free of any "hopperburn" until digging time. Triumph plants, on the other hand, while prevented from becoming badly diseased until after tubers had well developed, were affected much more by "hopperburn" than any other variety tested. Unsprayed Triumph plants died from the effects of "hopperburn" before the middle of the season.

HOW AND WHEN TO APPLY BORDEAUX.

To control the potato leafhopper, Bordeaux mixture *must* be applied to the underside of the leaves. The spraying must be done thoroughly, covering practically all of the foliage. Each side of every row of plants must be sprayed.

A high pressure (150 pounds at least) should be maintained in order to cover the leaves with a fine mist, which gives a much better coating than does a coarse spray. (Figs. 13, 14.)

In years when leafhoppers are abundant at least three applications of Bordeaux mixture should be made, the first as soon as the leafhoppers have appeared on the plants. It is often possible at

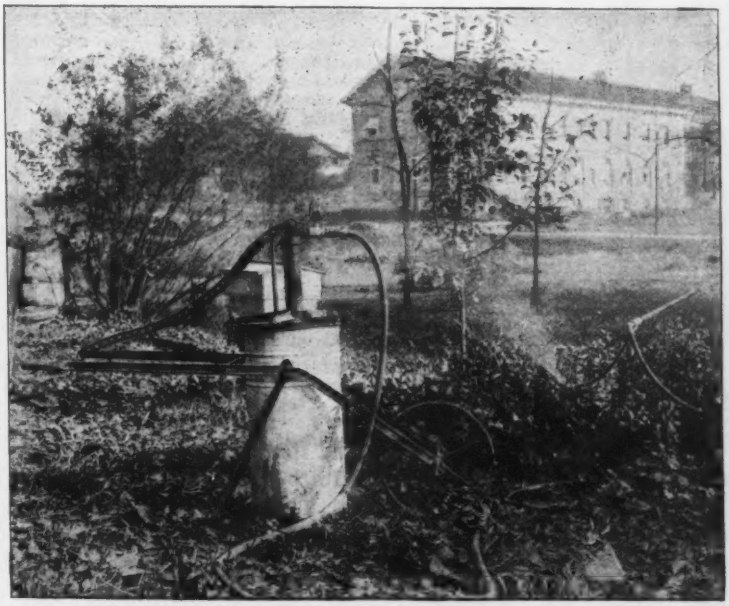

FIG. 13.—Good type of wheelbarrow sprayer effective for small patches. This sprayer holds 12 gallons, and 150 pounds pressure can be kept up when 2 nozzles are used.

this time to add an arsenical and control the Colorado potato beetle. The second spray should be applied from 10 days to 2 weeks later, depending upon the amount of spray remaining on the plants and the amount of new growth. A third and even a fourth spray might be necessary in very hot, dry summers and in years when leafhoppers occur in vast numbers.

As Bordeaux mixture is used for several purposes on potatoes—to repel fleabeetles and control certain diseases—it is most fortunate that it has been found to be a control for leafhoppers and "hopperburn" and may fit nicely into the regular spraying schedule.

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YIELDS.

It has been found that the yield of sprayed fields of early potatoes may be increased over 100 per cent above the yield of unsprayed fields, and the yield of sprayed fields of late potatoes increased over 50 per cent above the yield of unsprayed fields, by the use of Bordeaux mixture against the potato leafhopper and "hopperburn."

SUMMARY OF CONTROL MEASURES.

Spraying appears so far to be the best practical method of control for the potato leafhopper and for preventing the appearance or spread of "hopperburn."

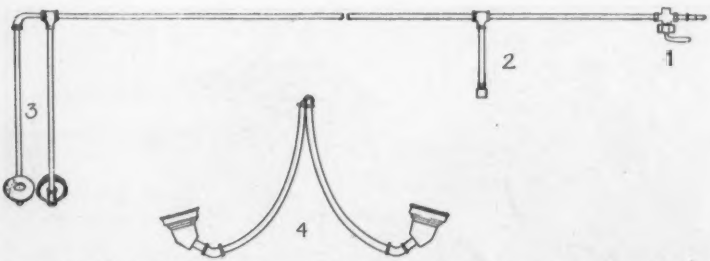

FIG. 14.—Details of sprayer shown in figure 13: *1*, Hose connection; *2*, handle to assist in holding and directing rod; *3*, adjustable booms and nozzles, side view; *4*, same, front view.

Bordeaux mixture 4–4–50 is the best spray to use.

It should be applied to the *underside* of the leaves thoroughly, at least 150 pounds pressure being used so that a fine mist spray will result.

Make at least three applications, and spray a fourth time if necessary to keep down "hopperburn" until the crop has matured.

To make the application thorough, spray both sides of each row.

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